MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2018/2019

EMG2016 – ELECTROMAGNETIC THEORY

(BE, RE, TE)

18 OCTOBER 2018
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 7 pages excluding cover page with 4 questions only.

2. Attempt ALL 4 questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

4. Please submit the completed Smith Chart together with the answer booklet.

QUESTION 1

a) It is desired to match a 50 Ω line to a load impedance of 60 - j50 Ω. Design a 50 Ω stub that will achieve the match. Find the length of the stub and how far it is from the load.

[15 Marks]

b) A stub of length 0.12λ is used to match a 60 Ω lossless line to a load. If the stub is located at 0.3λ from the load. Calculate

(i) The load impedance

[4 marks]

(ii) The length of an alternative stub and its location measure from the load

[4 marks]

(iii)The standing wave ratio

[2 marks]

QUESTION 2

a) In an air-filled rectangular waveguide, a TE mode operating at 6 GHz has.

$$E_y = 5\sin\left(\frac{2\pi x}{a}\right)\cos\left(\frac{\pi y}{b}\right)\sin(\omega t - 12z) \quad \text{V/m}$$

The speed of light in air is about 3×10^8 m/s. Determine

(i) the mode of operation,

[2 marks]

(ii) the free space phase constant,

[1 mark]

(iii) the waveguide phase constant,

[1 mark]

(iv) the cutoff frequency,

[3 marks]

(v) the TE wave impedance, and

[3 marks]

(vi) H_x

[4 marks]

Continued...

b) A 15 km link uses optical fiber with a loss of 1.75 dB/km. The fiber is joined every kilometer with connectors which give an attenuation of 0.85 dB each. Determine the minimum mean optical power which must be launched into the optical fiber in order to maintain a mean optical power level of 0.35 μW at the.

[6 marks]

c) Determine the dominant resonant frequency for an air-filled rectangular cavity of size $2\times3\times4$ cm^3.

[5 marks]

QUESTION 3

a) Explain the term "skin-depth" and give an expression of it for a perfect dielectric and a perfect conductor in terms of the electrical properties.

[4 marks]

b) The electric field of a plane wave propagating in a nonmagnetic material is given by

$$\underline{\mathbf{E}} = \hat{\mathbf{a}}_y 3\sin\left(\pi\times10^7 t - 0.2\pi x\right) + \hat{\mathbf{a}}_z 4\cos\left(\pi\times10^7 t - 0.2\pi x\right) \text{ (V/m)}$$

Determine

(i) the direction of wave propagation,

[2 marks]

(ii) the wavelength and phase velocity,

[4 marks]

(iii) the dielectric constant, ε_r of the medium,

[2 marks]

(iv) the wave impedance, and

[3 marks]

(v) the corresponding magnetic field.

[4 marks]

c) The electric field of a plane wave is given by.

$$\underline{\mathbf{E}}(z,t) = \hat{\mathbf{a}}_x 10\sin\left(\omega t - kz - 60°\right) + \hat{\mathbf{a}}_y 30\cos\left(\omega t - kz\right) \text{ (V/m)}$$

Determine

(i) the polarization angles (γ, χ) and [5 marks]

(ii) the polarization state. [1 mark]

(Hint: $\tan(2\gamma) = \tan(2\varphi)\cos(\delta)$ and $\tan(2\chi) = \tan(2\varphi)\sin(\delta)$)

Continued...

QUESTION 4

a) The loop in Figure Q4 is in the x-y plane and B = $\hat{z}\, B_o \sin(\omega t)$ with B_o positive.

(i) Derive the induced current equation,

[4 marks]

(ii) What is the direction of induced current, I on the loop at $t = 0$,

[3 marks]

(iii) Repeat (ii), at $\omega t = \pi/4$

[3 marks]

(iv) Repeat (ii), at $\omega t = \pi/2$

[5 marks]

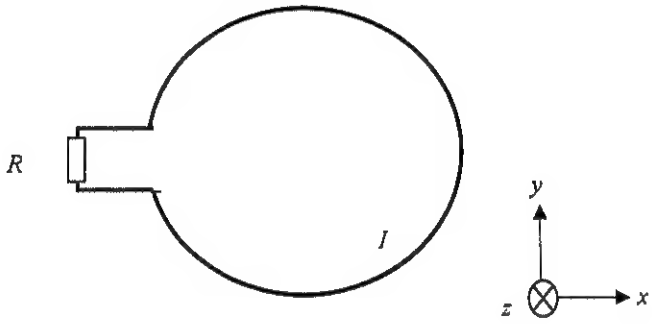

Figure Q4

b) A stationery conducting loop with resistance of 0.5 Ω is placed in a time-varying magnetic field. When the loop is closed, a current of 2.5 A flows through it. What will the current be if the loop is opened to create a small gap and a 2 Ω resistor is connected across its open ends. State the three situations that will induce V_{emf}

[6 marks]

c) State three situations that will induce V_{emf}.

[4 marks]

Continued...

Appendix : Physical constants

Constant	Symbol	Value
Speed of light in vacuum	c	$3x10^{8}$ m/s
Permittivity of free space	ε_0	$8.8542x10^{-12}$ F/m
Permeability of free space	μ_0	$1.2567x10^{-6}$ N/A^2
Intrinsic impedance of free space	η_0	377Ω

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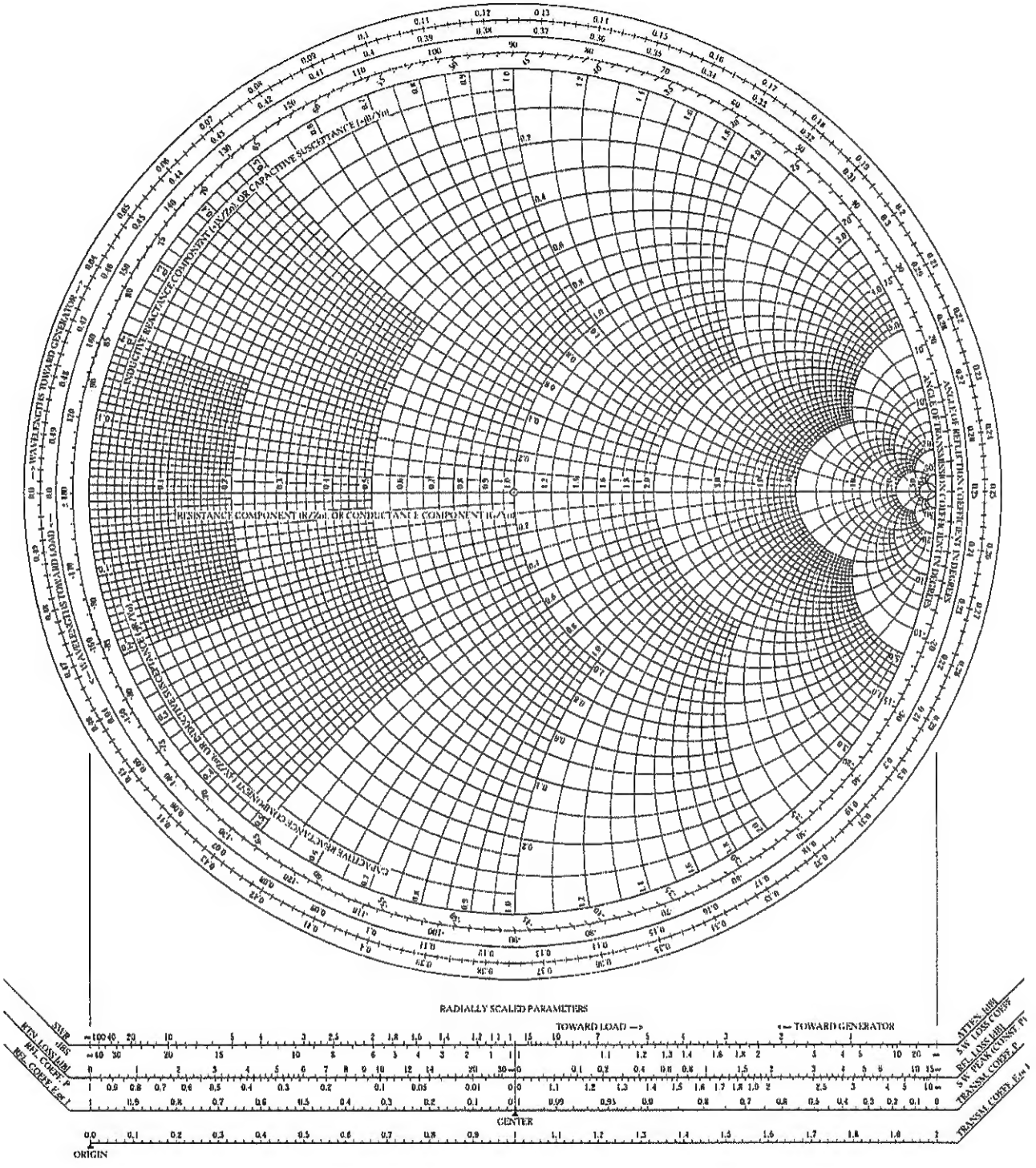
The Complete Smith Chart

Black Magic Design



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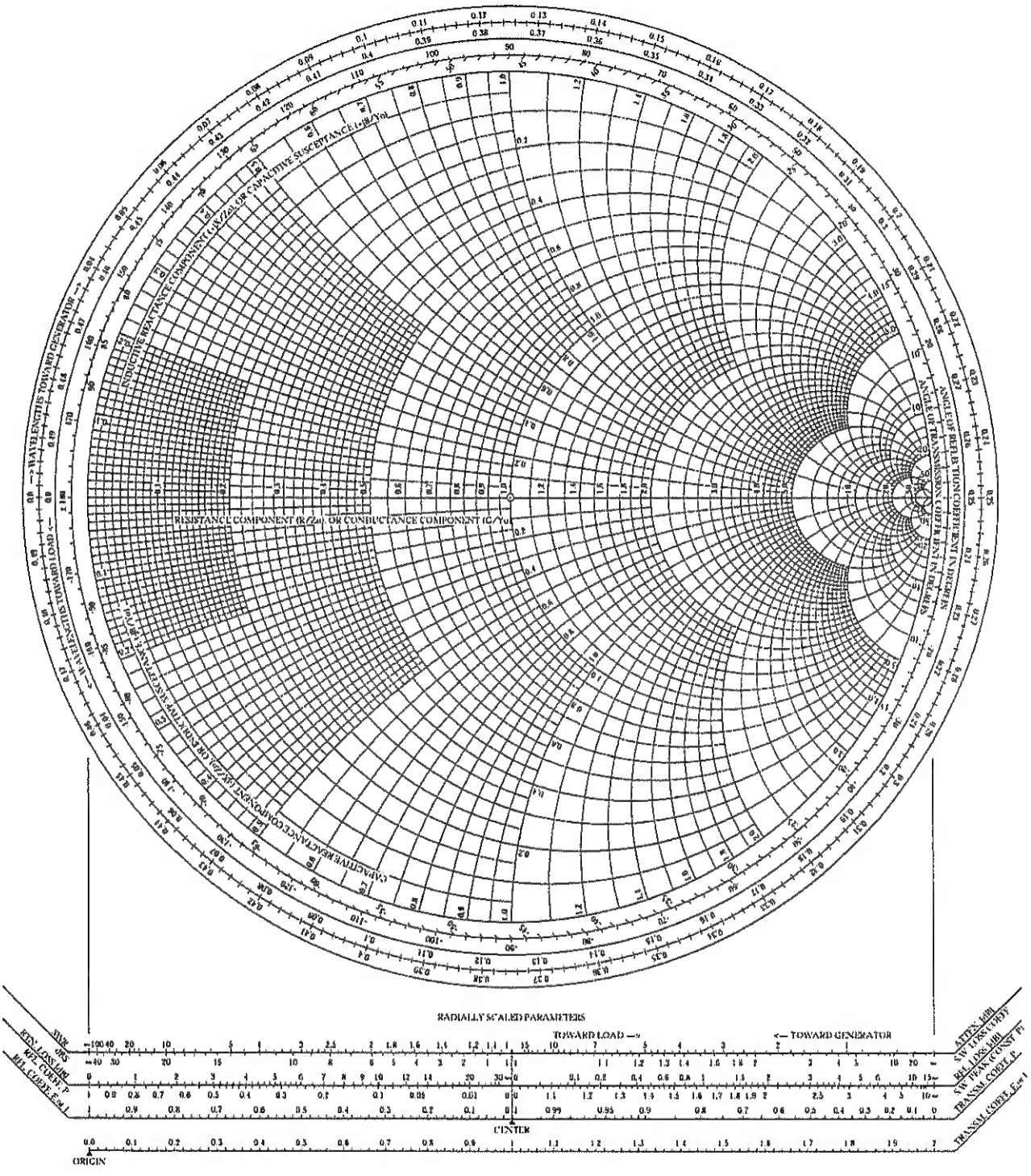

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The Complete Smith Chart

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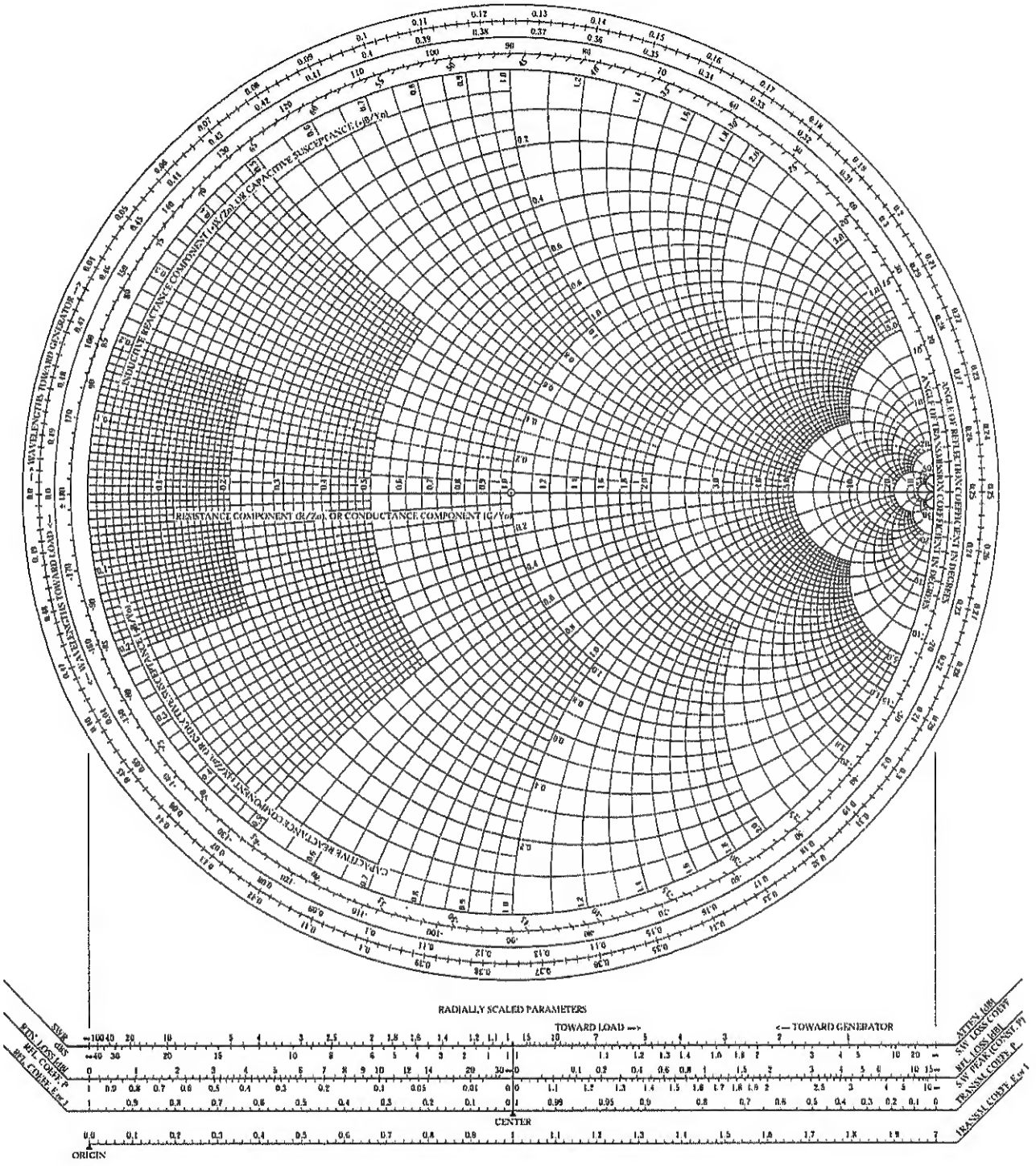

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